DOCUMENT RESUME

ED 313 671 CS 009 864

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TITLE Students' Beliefs about the Nature of Knowledge: What Are They and How Do They Affect Comprehension? Technical Report No. 484.
INSTITUTION Bolt, Beranek and Newman, Inc., Cambridge, Mass.; Illinois Univ., Urbana. Center for the Study of Reading.
SPONS AGENCY Office of Educational Research and Improvement (ED), Washington, DC.
PUB DATE Nov 89
CONTRACT G0087-C1001-89
NOTE 24p.
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Cognitive Structures; Cognitive Style; Content Area Reading; *Epistemology; Higher Education; Knowledge Level; Learning; Multiple Regression Analysis; Questionnaires; *Reading Comprehension; Reading Research; Two Year Colleges
IDENTIFIERS *Knowledge Acquisition

ABSTRACT

A study was conducted involving two experiments to address the question "What effects do students' beliefs about the nature of knowledge have on comprehension?" Experiment one involved 117 junior college students and 149 university students as subjects. An epistemological questionnaire was administered to the undergraduates. Factor analysis of the questionnaire resulted in four factors reflecting degrees of beliefs in innate ability, simple knowledge, quick learning, and certain knowledge. In experiment two, 86 of the junior college students who participated in experiment one read a passage from either the social sciences or the physical sciences, in which the concluding paragraph was removed. They rated their confidence in understanding the passage, wrote a conclusion, and completed a mastery test. Belief in "quick learning" predicted oversimplified conclusions and belief in "certain knowledge" predicted inappropriately absolute conclusions. Belief in quick learning predicted poor performance on the mastery level test and confidence rating. Results indicated that epistemological beliefs should be conceptualized in terms of several independent dimensions, each with distinct effects on comprehension. (Six tables of data are included and 24 references are attached.) (MG)

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ED313671

CENTER FOR THE STUDY OF READING

Technical Report No. 484

STUDENTS' BELIEFS ABOUT THE NATURE OF KNOWLEDGE: WHAT ARE THEY AND HOW DO THEY AFFECT COMPREHENSION?

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The work upon which this publication was based was supported in part by the Office of Educational Research and Improvement under Cooperative Agreement No. G0087-C1001-89 with the Reading Research and Education Center. The publication does not necessarily reflect the views of the agency supporting the research.

CS007864

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Abstract

Students' beliefs about the nature of knowledge, or epistemological beliefs, were assessed and the effects of these beliefs on comprehension were studied. In Experiment 1, an epistemological questionnaire was administered to undergraduates. Factor analysis of the questionnaire resulted in four factors reflecting degrees of belief in INNATE ABILITY, SIMPLE KNOWLEDGE, QUICK LEARNING, and CERTAIN KNOWLEDGE. In Experiment 2, students read a passage from either the social sciences or the physical sciences, in which the concluding paragraph was removed. Then, they rated their confidence in understanding the passage, wrote a conclusion, and completed a mastery test. Belief in QUICK LEARNING predicted oversimplified conclusions and belief in CERTAIN KNOWLEDGE predicted inappropriately absolute conclusions. Belief in QUICK LEARNING predicted poor performance on the mastery test and confidence rating. These results indicate that epistemological beliefs should be conceptualized in terms of several independent dimensions, each with distinct effects on comprehension.

STUDENTS' BELIEFS ABOUT THE NATURE OF KNOWLEDGE: WHAT ARE THEY AND HOW DO THEY AFFECT COMPREHENSION?

This research addresses the question, "What effects do students' beliefs about the nature of knowledge have on comprehension?" Recently there has been a growing interest in identifying what students believe about the nature of knowledge and learning, or personal epistemology (e.g., Feltovich, Spiro, & Coulson, 1987; Schoenfeld, 1983, 1985; Steinbach, Scardamalia, Burtis, & Bereiter, 1987). The motivation for these studies is the assumption that epistemological beliefs affect comprehension in important ways. Educational researchers have entertained the idea that epistemological beliefs may provide a partial explanation for such phenomenon as why some students integrate information and others do not (Anderson, 1984), why some students have flexible criteria for comprehension monitoring and others do not (Kitchener, 1983; Yussen, 1985), and why some students oversimplify information and others do not (Spiro, Vispoel, Schmitz, Samarapungavan, & Boerger, 1987).

Earlier attempts to investigate students' epistemological beliefs focused on developmental issues. Based on research involving a questionnaire and some in-depth interviews with Harvard undergraduates, Perry (1968) has suggested that students go through nine stages of development of epistemological beliefs. In the early stages, students see knowledge as either right or wrong with authority figures knowing the answers. As students progress, they begin to perceive knowledge as correct relative to various contexts. The right-wrong belief is now subordinate to relativistic thinking. When students reach the final stage of development, they realize that there are multiple possibilities for knowledge and there are times when one must make a strong, yet tentative, commitment to some ideas.

Research based on Perry's work has produced mixed results. Ryan (1984) investigated some of the educational implications of epistemological beliefs. Using seven items from Perry's questionnaire, Ryan categorized students into one of two categories, high "dualists" or high "relativists." When asked what their criteria were for determining if they had comprehended a textbook chapter, dualists reported using fact-oriented standards, such as recall of facts, whereas relativists reported using context-oriented standards, such as paraphrasing and application. In contrast, Glenberg and Epstein (1987, p. 87), using Ryan's dualism scale to predict comprehension monitoring, found that it "accounted for little of the variance and, thus, tended to waste degrees of freedom."

Such an inconsistency in results can perhaps be accounted for in terms of shortcomings in the current conception of epistemological beliefs. Perry, and most of those following him (e.g., Knefelkamp & Slepitza, 1976; Touchton, Wertheimer, Cornfeld, & Harrison, 1977; Ryan, 1984), have assumed that personal epistemology is unidimensional and develops in a fixed progression of stages.

A more plausible conception is that personal epistemology is a belief system that is composed of several more or less independent dimensions. Beliefs about the nature of knowledge are far too complex to be captured in a single dimension. I propose that there are at least five dimensions: the structure, certainty, and source of knowledge; and the control and speed of knowledge acquisition.

Previous research suggests that there may be more than one facet to epistemological beliefs. The notions of structure, certainty, and source can be derived from Perry's work (1968) in that he found many students enter college with the belief that knowledge is simple, certain, and handed down by authority. As they encounter complex and tentative information in higher education, they eventually come to believe most knowledge is complex, tentative, and reasoned out.

The belief about the control of the knowledge acquisition can be derived from Dweck's research (see Dweck & Leggett, 1988). She has studied the influence of students' beliefs about a single dimension, the nature of intelligence. She has found that some students have a predominant belief that intelligence is a fixed entity, whereas others believe it is incremental, that is, it can be improved. Students with a fixed entity theory of intelligence perceive the goal of an academic task is to document their intelligence. Students with an incremental theory of intelligence perceive academic tasks as an opportunity to improve their intelligence. When engaged in an easy task, these two types of students will perform similarly. When confronted with a difficult task, students with the entity theory will interpret the situation as negative documentation of their intelligence. They will display "helpless" behavior. That is, they will engage in negative self-talk, such as "I'm failing," perseverate on the same strategy, and finally cease to

try. Students with an incremental theory, on the other hand, will perceive the difficulty of the task as a challenge. They will engage in positive self-talk, such as "I have to try harder and longer," and use alternative study strategies. This is what Dweck calls an achievement motivation pattern. She has established these patterns of behavior through empirical research by manipulating beliefs to influence goal selection (Dweck, Tenney, & Dinces, 1982, cited in Dweck & Bempechat, 1983), by manipulating goals to influence response to difficult tasks (Elliot & Dweck, 1981, cited in Dweck & Bempechat), and by manipulating task difficulty to influence goal selection (Licht & Dweck, 1984).

The belief about the speed of knowledge acquisition can be derived form Schoenfeld's (1983, 1985) intriguing work with high school students' geometry proofs. In careful protocol analysis of geometry students' problem solving, Schoenfeld notes that students seem to be functioning with a set of underlying beliefs. Similar to Dweck's thinking, he finds that students seem to believe only the gifted, or someone very special, can derive theorems or be creative in mathematics. Hence, there is this notion that intelligence is a fixed entity. In addition, he noted that some students seem to believe in quick, all-or-none learning. They spend 10 to 12 minutes working on a problem. If they don't get it by then, they assume they never will get it.

In line with this rationale, I conducted a preliminary study (Schommer, 1988). To assess the five hypothesized epistemological beliefs, I wrote a questionnaire. Students were asked to rate their degree of agreement on a five-point scale to items such as, "Almost all of the information you can learn from a textbook you will get during the first reading." Then, I used Principle-Component analysis to specify dimensions of epistemological beliefs. To test the effects of these beliefs, students were confronted with either complex information, that is, information that needed to be integrated to be understood fully, or tentative information. The main experimental task was the "conclusion task." Students read a passage with one of two types of underlying resolution to conflicting information--multiple theories that need to be integrated or multiple theories whose complexity of interrelations makes an absolute conclusion inappropriate. These passages did not have concluding paragraphs. Rather, it was up to the students to imagine that they were the author of the passage and to write a concluding paragraph based on what was already written. Using multiple regression, the relationship between factor scores from the questionnaire and conclusions written by the students was then tested after the effects of verbal ability, prior knowledge, and gender were taken into account.

Students' written conclusions were related to their epistemological beliefs. For the Integrated Resolution passage, the more students believed in quick, all-or-none learning, the less likely they were to conclude that a resolution could be found by integrating theories. For the No Resolution passage, the more students acknowledged uncertainty in the world, the more likely they were to describe the conclusion as unresolvable.

This preliminary study laid the ground work for the two experiments being reported. It provided some initial evidence that conceptualizing epistemological beliefs as a set of more or less independent dimensions is useful in that their effects appear to be different.

The remainder of this report describes two experiments. Experiment 1 serves to test the conceptualization that epistemological beliefs are a system of more or less independent beliefs and to explore factors that might predispose students to have certain epistemological persuasions. To improve the questionnaire used in the preliminary study, the size of the sampling was increased and the composition of the sampling was diversified. To explore what factors might predispose students to have certain epistemological persuasions, a survey of students' background was prepared. In this survey, students were asked to report information, such as their year in school and age, their parents' education and occupations, and aspects of their upbringing, such as routinely doing weekly chores and engaging in serious discussions with their parents. In addition, students completed a wide-range vocabulary test. Epistemological dimensions were derived from the questionnaire with factor analysis, then the relationship between these factors and students' responses to the survey was examined.

Experiment 2 serves to link epistemological beliefs to aspects of students' comprehension, including interpretation of information, which was measured with the conclusion task; learning typical of the classroom, which was measured with a passage mastery test; and monitoring their understanding, which was measured with students' confidence ratings in their understanding of the passage. An additional

purpose of the second experiment was to test the generalizability of the effects of epistemological beliefs across passages in different domains. In the preliminary study, both passages were from the social sciences. In this study, one passage was from social sciences and the other passage was from the physical sciences. Finally, I wanted to test the effects of epistemological beliefs beyond the effects of factors sometimes known to influence comprehension. Therefore, links between epistemological beliefs and comprehension were tested by regressing epistemological dimensions derived from Experiment 1 on comprehension measures obtained in Experiment 2 after the effects of verbal ability, prior knowledge, and gender were removed.

EXPERIMENT 1

Method

Subjects

The study being reported here was carried out in a midwestern city. It involved 117 junior college students and 149 university students as subjects. The junior college students were enrolled in an introductory psychology class, which was a general requirement for all students. The university students were enrolled in either an introductory educational psychology class (n = 76), which was a requirement for all education majors, or an introductory physics class (n = 73), which was a requirement for all engineering majors. Over 95% of the students were either freshmen or sophomores. There was an approximately equal number of men and women (men = 120, women = 143). Three students did not report their gender.

Materials

Overview of materials. Four booklets were prepared for group administration of the following instruments: (a) wide-range vocabulary test (French, Ekstrom, & Price, 1963), (b) epistemological questionnaire, (c) student characteristics survey, and (d) filler task. The general purpose of the first three booklets is self-evident. The filler task was included to keep students who finished early occupied.

Epistemological questionnaire. The questionnaire used in the preliminary study was modified with the same five hypothesized epistemological beliefs in mind. Stated from a naive epistemological persuasion, these beliefs, and shorthand terminology in parentheses, are the following: (a) Knowledge is simple rather than complex (SIMPLE KNOWLEDGE), (b) Knowledge is handed down by authority rather than derived from reason (OMNISCIENT AUTHORITY), (c) Knowledge is certain rather than tentative (CERTAIN KNOWLEDGE), (d) the Ability to learn is innate rather than acquired (INNATE ABILITY), and (e) Learning is quick or not-at-all (QUICK LEARNING).

Two or more subsets of items were prepared to assess each epistemological dimension. For example, there are at least two ways that learners can oversimplify complex information. They can focus on one aspect of the information, or they can compartmentalize pieces of information. These two notions were tested by items that tapped either a preference for single answers or a preference for discrete facts (avoidance of integration of information). Table 1 shows the titles of the epistemological dimensions, the subsets of items within each dimension and an example of an item in each subset for this 60 item test.

[Insert Table 1 about here.]

To avoid response bias, care was taken to have an approximately even distribution of items with a positive and negative valence with respect to a particular epistemological persuasion. From a naive epistemological view, there were 28 items with a negative valence and 35 items with a positive valence. Students were asked to rate their degree of agreement for each item on a scale from 1 (strongly disagree) to 5 (strongly agree).

Survey of student characteristics. To examine the relationship between epistemological beliefs and characteristics of the learner, a survey of students' personal characteristics and home background was

prepared. Basic information, such as age, gender, year in school, parents' occupation and parents' education were requested. In addition, items that assessed students' upbringing were included. These items covered three main categories: (a) characteristics of family structure (e.g., single parent), (b) adherence to rules (e.g., enforcement of strict rules), and (c) encouragement toward independence (e.g., making decisions for one's self). Students rated these upbringing items on a scale from 1 (never) to 6 (always).

Procedure

Group administration was possible for both the junior college and university educational psychology students. For these students, the experimenter introduced the vocabulary test. After five minutes, students were told to begin the second booklet. All tasks were self-paced except for the vocabulary test. When all the students had completed the first three booklets, the session was ended.

Physics students were only available on an individual basis. The class professor informed these students that booklets were available to be picked up when leaving class and that they should fill them out independently from any other student and return them to the next class.

Results and Discussion

Assessing Epistemological Beliefs

Factor analysis made it possible to determine how many and which factors could account for students' responses on the questionnaire. The 12 subsets of items were used as variables in this analysis. Using principal factoring extraction with orthogonal varimax rotation and an eigenvalue greater than one as a cutoff point for factors, four factors were generated that accounted for 55.2% of the variance. Factors were given descriptive titles based on high-loading subsets of items (factor loading greater than .50). Table 2 shows the factor loadings for these subsets. The factor titles and their abbreviated labels are as follows: Factor I--Ability to learn is innate (INNATE ABILITY), Factor II--Knowledge is discrete and unambiguous (SIMPLE KNOWLEDGE), Factor III--Learning is quick or not-at-all (QUICK LEARNING), Factor IV--Knowledge is certain (CERTAIN KNOWLEDGE).

[Insert Table 2 about here.]

To determine if these factors would better be described as correlated, plotted factor graphs were examined and several oblique rotations were computed. The plotted factors indicated that only 1 pair out of a possible 6 pair of factors looked somewhat correlated (Factors I and III). This is apparent from Table 2, which shows that the subset of items described as quick, all-or-none learning has a moderate loading on Factor I, as well as a high loading as its own unique Factor (III). However, oblique rotations did not lead to clearer, more interpretable factors.

Since oblique rotations did not differ much from the orthogonal rotation, the latter rotation was used because it was the most simple and eloquent of the two. These results suggest that epistemological beliefs may be characterized as a set of more or less independent beliefs. A set of four factors, rather than a single factor was generated. The extension of the conceptualization of epistemological beliefs provided a broader spectrum of what students' beliefs about the nature of knowledge and learning are.

Exploring Predictors of Epistemological Beliefs

Exploring variables that predispose students to have certain epistemological beliefs was conducted, first by studying the relationship between students' characteristics and each of the four epistemological factors, and second, by determining if there are differences in epistemological beliefs among groups of students.

Student characteristic variables were categorized into five blocks: (a) social/personal variables (e.g., age and gender), (b) cognitive variables (e.g., year in school and verbal ability), (c) educational atmosphere and opportunity variables (e.g., parents' highest education and parents' highest occupational prestige

score)(Treiman, 1977), (d) encouragement toward independence variables (e.g., allowed to voice opinion and question parents' decisions), and (e) adherence to rules or to guidelines variables (e.g., family strictness to rules and to religion). Because there was a possibility of multicollinearity within blocks, each epistemological factor was regressed on each block of student characteristics in order to determine which variables in each block would best represent that block. Variables within each block competed for entry in forward selection. Table 3 shows the overall results of these analyses. Throughout this report, an effect will not be reported unless it is statistically significant at least at the .05 level.

[Insert Table 3 about here.]

Especially notable in the findings is that there seems to be a particularly strong effect of students' upbringing and education on their beliefs in SIMPLE KNOWLEDGE and QUICK LEARNING. The interesting finding is that none of the variables surveyed predicted belief in CERTAIN KNOWLEDGE. One variable (recorded in Experiment 2) that was available for the junior college students but not for the university students was the number of classes they had completed in higher education. When CERTAIN KNOWLEDGE was regressed on this variable, the results were significant ($F(1,65) = 6.23$, $b = -.25$; $SD = .09$). The more classes students have completed in higher education, the more likely they are to believe knowledge is tentative. This suggests that exposing students to more advanced knowledge, which is generally more tentative in nature, facilitates a change in their belief systems with regard to the uncertainty of knowledge.

Two questions were asked about the differences between junior college students and university students: Are there differences between these groups?; and Can these differences be explained by student characteristics and home background? To answer these questions, each epistemological factor was regressed on schools, first without background variables removed, and second, with background variables removed. When background variables were not included in the analyses, the junior college students and university students differed on all epistemological dimensions. University students were more likely to believe in INNATE ABILITY (F (1,251) = 18.95, $b = .43$, $SD = .10$). Junior college students were more likely to believe in SIMPLE KNOWLEDGE ($F(1,251) = 10.12$, $b = -.2$, $SD = .10$), CERTAIN KNOWLEDGE ($F(1,251) = 4.23$, $b = -.17$, SD - .08), and QUICK LEARNING ($F(1,251) = 3.92$, $b = -.19$, $SD = .10$). Differences between schools in beliefs about SIMPLE KNOWLEDGE and QUICK LEARNING were eliminated when background variables were entered into the equation. It appears that students' home background has a substantial effect on these beliefs. On the other hand, differences between university and junior college students beliefs in INNATE ABILITY and CERTAIN KNOWLEDGE remained significant (INNATE ABILITY): $F(1,242) = 14.90$, $b = .40$, $SD = .10$; CERTAIN KNOWLEDGE: $F(1,241) = 5.13$, $b = .19$, $SD = .08$) and appear to be influenced by variables not included in this study.

I can only speculate as to why differences in beliefs in INNATE ABILITY and CERTAIN KNOWLEDGE remained after background variables entered the equations. With regard to differences in the belief about INNATE ABILITY, university students may have experienced a great deal of academic success and, consequently, attribute their success to genetic influence. Junior college students, on the other hand, may be a self-selected group of individuals who have experienced less academic success. Despite their previous experiences, they have enrolled in an institution of higher learning to improve their status. This might reflect some sort of faith in the educational process, perhaps a belief that their learning skills, as well as content knowledge, can improve (C. Dweck, personal communication, February 1989). Differences between groups in the belief about CERTAIN KNOWLEDGE may be a consequence of the type of course work to which students have been exposed. If university students have enrolled in theoretical courses, they have faced the uncertainty of hypothesis testing. If junior college students have taken predominately technical courses, they may have only been exposed to procedural knowledge--e.g., "how to" courses. The issue of uncertainty does not arise in these courses. Despite their plausibility, these post hoc interpretations need to be tested.

Although, on average, university students had more sophisticated beliefs than junior college students, it should be emphasized that not all university students have sophisticated beliefs. For example, as can be seen in Table 4, each school has a substantial number of students who believe in single answers, dependence on authority, certainty of knowledge, and avoidance of ambiguity. Hence, even though

differences can be found between groups on epistemological factors, no group is without members with less sophisticated beliefs.

[Insert Table 4 about here.]

EXPERIMENT 2

Method

The purpose of this experiment was to examine the relationship between epistemological beliefs, assessed in Experiment 1, and aspects of comprehension. Specifically, this experiment tested the effects of epistemological beliefs on conclusions drawn, performance on a mastery test, and comprehension monitoring. In addition, it is important to determine if these effects occur beyond the influence of factors known to influence comprehension, such as prior knowledge and verbal ability, and that these effects are generalizable across passages in different domains.

Design

Students read a passage, either in the domain of social science (psychology) or the domain of physical science (nutrition), and then completed several comprehension tasks.

Subjects

Subjects in this experiment were 86 of the 117 junior college students who participated in Experiment 1. Subjects were lost either because they dropped the class or they were absent the day of the experiment. Forty-one students (22 men and 19 women) read the psychology passage and 45 students (19 men and 25 women) read the nutrition passage.

Materials

Passages. Excerpts of texts from two different domains were used to assess the effects of the epistemological beliefs on comprehension. The psychology passage (Baron & Byrne, 1977) presented four plausible theories of aggression with the underlying theme that any tentative resolution would require a theory that integrates aspects of all four theories. The nutrition passage (Jacobsen, 1986) highlighted controversial issues of the daily recommended allowance of B-6 and recent inconclusive findings that vitamin B-6 may help with sickle-cell anemia, bronchial asthma, and premenstrual syndrome. No concluding paragraph was included for either passage.

Written conclusion task. Students were asked to write a concluding paragraph for the passage. The instructions were as follows:

> Imagine that you are the *author* of the textbook chapter that you read for this research project. You've got it all done except for the conclusion. Please complete the chapter by writing a good final paragraph that *draws a conclusion (or conclusions)* based on what is already written in the chapter. Be as clear as possible in your conclusion.

Mastery tests. A mastery test was prepared for each passage. The tests were composed of 10 multiple choice items and represented what might typically be asked in a classroom. Items tested the recognition and application of main ideas in the passages.

Prior knowledge. As an indicator of prior knowledge, students were asked to report the number of classes they had taken in psychology, sociology, biology, nutrition, and health sciences. Classes relevant to the passage read were totaled.

Confidence ratings. Accuracy of comprehension monitoring was assessed with the confidence accuracy paradigm. First, students were asked to rate their confidence in understanding the passage. The rating scale, which has been used in previous research (Schommer & Surber, 1986), ranged from 1 ("I

understood very little of this chapter. I could not answer questions on this material.") to 4 ("I understood this chapter very well. I could explain the main points of this material to another person."). Instructions were written in such a way as to avoid subjects being hesitant to chose a low confidence rating for fear it would reflect an inadequacy in themselves.

Then a comparison was made between students' confidence ratings and their test performance. The illusion of knowing has been operationally defined as students having high confidence in their comprehension and concurrently performing poorly on a comprehension measure (Glenberg, Wilkinson, & Epstein, 1982). In the research reported here, a mismatch between student confidence ratings and their performance on the 10-item mastery test was used to test for the illusion of knowing.

Filler task. As in Experiment 1, the purpose of the filler task was to keep students who had finished early occupied while the remaining students completed the experimental materials. The filler task included a picture completion test and map drawing test (French, Ekstrom, & Price, 1963).

Procedure

Passages were randomly distributed to students to be read at home. Comprehension tests were to be completed in the following class session. For one class of night students, who met once a week, the passages were distributed the week before. For three classes of day students, who met four times a week, the passages were distributed the night before. In the following class session comprehension booklets were distributed. The materials in three booklets were sequenced as follows: (a) confidence rating, (b) number of classes in each domain, (c) written conclusion, (d) mastery test, and (e) filler tasks. Students were asked to read the directions on each page, then complete the page. No page was to be skipped. They were not to turn back in the booklet. When all students were working on the filler task, the session was ended and students were debriefed.

Conclusions for both passages were coded for both simplicity and certainty using a dichotomous scale. Interrater agreement for this scoring was 93%. If students oversimplified text information by describing a single point of view or avoided drawing a conclusion, their conclusions was scored as simple. If students elaborated on text information or showed integration of key points, their conclusions were scored as complex. If students wrote conclusions that said "we have the answer" or "we will have the answer in the future," their conclusions were rated as certain. If students suggested uncertainty now or in the future, their conclusions were scored as uncertain. Tables 5 and 6 show examples of each type of conclusion.

[Insert Tables 5 and 6 about here.]

Students' ability to assess their understanding of the passage they read was scored as a continuous variable. A range from +10 to -10 score of illusion of knowing was calculated by subtracting the predicted test performance from the actual test performance. Students who have a negative score (IK-) underestimate their comprehension. Students who have a positive score (IK+) overestimate their comprehension. Students who have zero as a score have judged their comprehension accurately.

Results and Discussion

Hypotheses were tested using multiple regression analysis. For each test, a set of background variables that may account for performance on comprehension measures was entered in forward inclusion regression before the four epistemological factors competed for entry. These background variables included verbal ability as measured by the wide-range vocabulary test, prior knowledge as measured by the number of relevant classes that students had taken, and gender. The square root of classes was used, since it provided a more normalized distribution of this measure.

To test for the effects of epistemological beliefs on the interpretation of information and the generalizability of these effects across passages in different domains, an analysis of the students' conclusions for the combined passages was tested. Passage domain was entered first as a replication variable, followed by background variables, epistemological factors, and epistemological factors by passage domain interaction term. QUICK LEARNING predicted oversimplified conclusions ($F(1,59)$

= 7.47, b = -.18, SD = .07). The more students believed in quick, all-or-none learning, the more likely they were to oversimplify conclusions. CERTAIN KNOWLEDGE predicted certain conclusions (F(1,57 = 8.50, b = -.33, SD = .11). The more students believed in certain knowledge, the more likely they were to write absolute conclusions. Prior knowledge also predicted certain conclusions (F(1,60 = 5.86, b = .22; SD = .09). The more courses students had completed the more likely they were to write tentative conclusions.

These findings replicate the results of my previous research. In both analyses, there was no main effect for passage domain nor was there a significant interaction of passage domain by epistemological factor. This suggests that the effects of beliefs of QUICK LEARNING and CERTAIN KNOWLEDGE are generalizable across the domains of psychology and nutrition.

To test for the effects of epistemological beliefs on tasks similar to the classroom, each mastery test was regressed on the epistemological factors after the effects of background variables were removed. QUICK LEARNING predicted performance on the aggression mastery test (F(1,26) = 9.15, b = -1.16; SD = .38). The more students believed in quick, all-or-none learning, the more likely they were to perform poorly on the aggression mastery test. None of the epistemological factors predicted performance on the B-6 mastery test. A close examination of the B-6 test revealed that a substantial number of items had either a floor or ceiling effect. This suggests that the B-6 mastery test was not a valid measure for that passage. The aggression test was psychometrically sound with regard to this measure. Using the aggression passage mastery test as the dependent measure, it appears that epistemological beliefs may influence performance on tasks similar to those used in the classroom.

As discussed earlier, students' ability to assess their understanding of the passage was tested by comparing their confidence rating with their performance on the mastery test. Since the B-6 test was not psychometrically sound, only the performance of students reading the aggression passage was analyzed. QUICK LEARNING predicted students' overestimation of their understanding of the passage (F(1,25) = 12.62, b = -.81, SD = .23). The more students believed in quick, all-or-none learning, the more likely they were to overestimate their understanding of the passage. None of the epistemological factors predicted students' underestimation of their understanding.

General Discussion

This study suggests five conclusions: (a) personal epistemology can be characterized as a system of more or less independent beliefs, (b) these beliefs have distinct effects on comprehension and learning, (c) these effects are generalizable across two content domains, (d) these effects exist beyond the influence of variables found to influence comprehension and learning, and (e) epistemological beliefs are influenced by home and educational background.

The composition and structure of personal epistemology as a system of more or less independent beliefs was reflected in the results of two factor analyses, in my preliminary study (Schommer, 1988) and in the present study. This multiplicity of dimensions not only begins to reveal the composition of personal epistemology, but also has provided a means to test the different effects of each dimension on comprehension and learning.

An important finding is that epistemological beliefs affect students' processing of information and monitoring of their comprehension. When encountering complex information, belief in quick, all-or-none learning appears to affect the degree to which student integrate knowledge. In addition, this same belief affects students' accuracy in assessing their own comprehension. Undoubtedly there are other epistemological beliefs that are important and need to be considered. Modifying the present questionnaire and using different measures to provide converging evidence would sharpen the detection of these beliefs.

It is noteworthy that epistemological beliefs appear to affect the critical interpretation of knowledge. That is, it was not a question of students being able to recall prominent information in the passages, but rather, one of what they concluded from the information. When encountering content material that is tentative, strong beliefs in the certainty of knowledge appears to lead to distortion of information in order to be consistent with this belief. Of course, the effects of epistemological beliefs on

comprehension, learning, and critical interpretation need to be clarified. The interrelationship of prior knowledge, epistemological beliefs, and study strategies is a major issue that needs to be studied in the next decade.

The generalizability of these findings lends credence to the important influence of epistemological beliefs. These findings were consistent across a preliminary study and this study and across passages from two domains. In addition, these effects were found after measures of verbal ability and prior knowledge were removed. Future research needs to continue testing the generalizability of the effects of epistemological beliefs on different passages, different domains, and different aspects of comprehension.

Examining the relationship between personal epistemology and students' characteristics revealed intriguing results. The results of the study reported here support a conjecture made by Anderson (1984) that parents and teachers are mediators of children's understanding of the world and maybe their epistemological beliefs. These results suggest that the more education parents have and the more they expect their children to take responsibilities in the home and for their own thinking, the more likely children will develop a sophisticated system of epistemological beliefs. That education influences students' epistemology is apparent in regression analyses showing the effect of years in school on beliefs of discrete, unambiguous knowledge and quick, all-or-none learning. The influence of education is particularly obvious in the finding that of all the variables examined in these studies, only the number of college-level classes completed predicted belief in the uncertainty of knowledge.

Illuminating results came from differences found between students with respect to their epistemological beliefs. When students' background was not considered, differences in all four epistemological beliefs were found between junior college students and university students. Once students' background was taken into account, differences in beliefs about discrete, unambiguous knowledge and quick, all-or-none learning were eliminated. This provides additional evidence of the influence of home life. Yet differences remained between these groups in their beliefs about the ability to learn and the certainty of knowledge.

I have speculated as to why these differences in students' epistemological beliefs remain. One speculation is that some students may have been quite successful in school and may not be consciously aware that some of their ability to learn was acquired, whereas others sense that continuing in higher education may enhance their learning ability, as well as their content knowledge. Another speculation is that students who have not been made aware of the tentativeness of knowledge, who have not taken classes that go past stating facts as if they were written in stone, will not believe that knowledge is probabilistic and evolving. In short, if students are seldom required to integrate information or if they are seldom challenged with the fragility of knowledge, they may not acquire sophisticated epistemological beliefs. Indeed, under those task demands, they will not need sophisticated beliefs. It is when they encounter complex and uncertain information in higher education and, perhaps in life, that their less sophisticated system of epistemological beliefs will be inadequate.

Although differences were found between junior college students and university students, neither group was totally immune from some unproductive epistemological views. Both groups contained a large percentage of students who believe in single answers, dependence on authority, certainty of knowledge, and avoidance of ambiguity. These results are consistent with Perry's findings (1968) that in the first two years of college, students generally believe in certain answers handed down by authority. But in the study reported here, it was also found that a substantial number of students have strong beliefs in quick learning and innate ability. Most importantly, these beliefs have different effects on comprehension.

Insight into epistemological beliefs advances our understanding of human learning. Research in the past 20 years has emphasized the importance of schemata and metacognition on comprehension. However, schema theory cannot explain why background knowledge is not always accessed when it is needed. It cannot explain why some students fail to integrate information. The concept of metacognition does not itself explain why some students fail to monitor their comprehension. Some reasonable answers may be found in the study of epistemological beliefs. Notably, belief in discrete facts and unambiguous knowledge may explain failure to access prior knowledge and failure to integrate knowledge. Belief in quick learning appears to uncover another possible reason why students fail to integrate information,

as well as fail to monitor their comprehension. Beliefs in certain knowledge seems to explain why students make decisive interpretations when information is tentative.

What are the implications of epistemological beliefs for education? It seems education could provide a means for the intervention and prevention of self-defeating epistemological beliefs. Anderson (1977) has made the argument that students often do not change their schemata, rather, many of them learn to keep new knowledge isolated from their prior knowledge. One good way to compel students to compare, integrate, or accommodate new information is through the Socratic method of asking students challenging questions and requiring them to justify their answers. Now it is being suggested that raising students' consciousness about the underpinnings of knowledge and learning, and how their own epistemological views influence their learning may have the same effect as the Socratic method suggested by Anderson. Interestingly, it may be that the best way to modify epistemological beliefs is through the Socratic method.

Education may also be the key to the prevention of unsophisticated epistemological beliefs. Family influence notwithstanding, teachers can instruct children in grade school that knowledge is integrated, that prior knowledge should be accessed, and that many times there is more than one right answer. Indeed, anecdotal evidence suggests that many of the disabling epistemological beliefs that students have by high school have come from the way they have been taught (Schoenfeld, 1983).

That the study of epistemological beliefs is important seems undeniable. The fact that both epistemological beliefs and the effects of these beliefs are subtle highlights the need for careful investigation. Studying these beliefs, finding their niche among factors that we have studied for years, and determining how they affect learning will enable us to better understand the mind. With this understanding, we can guide students to become thoughtful, persistent, and independent learners.

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This study is based on a thesis submitted in partial fulfillment of the Doctoral degree of Education at the University of Illinois at Urbana-Champaign.

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Table 1

Overall Scheme of the Epistemological Questionnaire and Sample Items

EPISTEMOLOGICAL DIMENSION Subset Dimension "Sample Item"	No. of Items
SIMPLE KNOWLEDGE	
Seek Single Answers "Most words have one clear meaning."	11
Avoid integration "When I study I look for specific facts."	8
CERTAIN KNOWLEDGE	
Avoid ambiguity "I don't like movies that don't have an ending."	5
Knowledge is certain "Scientists can ultimately get to the truth."	6
OMNISCIENT AUTHORITY	
Don't criticize authority "People who challenge authority are over-confident."	6
Depend on authority "How much a person gets out of school depends on the quality of the teacher."	6

(Table 1 continued)

EPISTEMOLOGICAL DIMENSION Subset Dimension "Sample Item"	No. of Items
INNATE ABILITY	
Can't learn how to learn "Self-help books are not much help."	5
Success is unrelated to hard work "The really smart students don't have to work hard to do well in school."	4
Ability to learn is innate "An expert is someone who has a special gift in some area."	4
QUICK LEARNING	
Learning is quick "Successful students learn things quickly."	5
Learn first time "Almost all the information you can learn from a textbook you will get during the first reading."	3
Concentrated effort is a waste of time "If a person tries too hard to understand a problem, they will most likely just end up being confused."	2

Table 2

Four Orthogonal Factors Using Subsets of Items as Variables

	Factor I	Factor II	Factor III	Factor IV
Learn first time	.62	.01	.06	-.05
Can't learn how to learn	.56	.06	.10	-.03
Success is unrelated to hard work	.55	.14	.09	.28
Ability to learn is innate	.34	.23	.19	.04
Avoid ambiguity	.14	.68	.06	-.03
Seek single answers	.07	.56	.01	.13
Avoid integration	.04	.54	.14	.04
Don't criticize authority	.08	.33	.30	.26
Depend on authority	.25	.27	-.20	-.07
Learning is quick	.34	.13	.72	.08
Knowledge is certain	.04	.11	.11	.53
Concentrated effort is a waste of time	.28	.10	.12	-.27

Table 3

Student Characteristics and Home Background Variables That Predict Epistemological Beliefs

INNATE ABILITY	SIMPLE KNOWLEDGE	QUICK LEARNING	CERTAIN KNOWLEDGE
Age	Socio-Economic Index of Career Goal	Gender[a]	ns
ns	Verbal Ability	Year in school	ns
ns	Highest Parental Education	Father's Education	ns
Strict Rules	Decisions	Discussion	ns

Note: All *b* weights were negative. For example, the older the students were, the more likely they were to believe the ability to learn is acquired.

[a]Men were more likely to believe in QUICK LEARNING.

Table 4

Percentage of Students That Average 3 or Higher on Item Subsets that Reflect a Naive Epistemological Persuasion

	Junior College	University
Learn first time	15	33
Can't learn how to learn	13	27
Success is unrelated to hard work	25	33
Ability to learn is innate	55	64
Avoid ambiguity	89	84
Seek single answers	96	82
Avoid integration	79	55
Don't criticize authority	25	17
Depend on authority	77	85
Learning is quick	24	18
Knowledge is certain	79	71
Concentrated effort is a waste of time	59	57

Table 5

Examples of Simple and Complex Conclusions

VITAMIN B-6 PASSAGE	
Simple Conclusion:	"As you now well know, vitamin B-6 is a very important part of you and your children's everyday diet. So make sure you get enough, and keep that engine of yours well oiled!"
Complex Conclusion:	"Vitamin B-6 has some advantages and possible disadvantages. When taking the correct dosage (a little over 1.3 milligrams), vitamin B-6 has no side effects. When the dosage is increased to 500 or even up to 2,000, people have experienced numbness, nervous gaits, and other side effects. However, large doses seem to cure some diseases like PMS, asthma, and sickle cell disease. Too small a dose can harm the body also. Taking in less 1.3 milligrams a day can cause some serious health problems."
AGGRESSION PASSAGE	
Simple Conclusion:	"After telling you about aggression, I hope you understood it. There are very many problems with aggression and they are trying to solve them as soon as possible. The most problem that their is with the children that have this problem. The social learning of aggression is the best describtive word this" [*sic*].
Complex Conclusion:	"Aggression. There are many theories on behavior and the reason people are or become aggressive. I believe that the combination of several of these theories and not just one, comes close to the answer."

Table 6

Examples of Certain and Uncertain Conclusions

VITAMIN B-6 PASSAGE	
Certain Conclusion:	"If a person could find the exact dose of vitamin B-6 to take; neither too much which could destroy the nervous system nor too little which could cause other vitamin deficiency problems to develop, vitamin B-6 could serve as a cure for sickle cell, PMS and asthma. Until vitamin B-6 is studied more intensely on how much of a cure it can be, it is advised that one not try to add more vitamin B-6 to their diet."
Uncertain Conclusion:	"It is not proven that B-6 vitamin is good or not for asma, prementrual, sickle cell, Bronchi diseases" [*sic*].
AGGRESSION PASSAGE	
Certain Conclusion:	"Freud research the innate behavior of aggression and _____ studied the environmental stimulus approach to aggressive behavior, it is now agreed upon that social conditioning & rewards greatly effect human aggressive behavior" [*sic*].
Uncertain Conclusion:	"The theories presented in this text are in no way concrete. Just as there is no conclusive support to definitely assert that violence comes from somewhere deep inside every human, aggrivated [*sic*] by outside forces, or merely learned. It is quite possible, considering what complex beings humans are, that dangerous acts of violence are sparked by a combination of all three."